HW: p. 580: 3, 7

p. 582: 27, 31, 33

TEST Wednesday 4/25

A 120 g piece of copper is suspended by a string in a pot of boiling water. The copper is then pulled out of the boiling pot and lowered into a cup of water that is originally at 22 degrees C. The mass of water is 80 g and the mass of the cup is negligible. Find the equilibrium temperature.

$C_c = 387\ J/kg \cdot °C$

$C_w = 4186\ J/kg \cdot °C$

$$Q_{copper} = -Q_{water}$$

$$m_c c_c (T_{eq} - T_i) = -m_w c_w (T_{eq} - T_i)$$

ALGEBRA

$$T_{eq} = 31.44°C$$

A 0.05 kg ingot of metal is heated to 200 degrees C and then dropped into a calorimeter containing 0.4 kg of water initially at 20 degrees C. The final equilibrium temperature of the mixed system is 22.4 degrees C. Find the specific heat of the metal.

$$c_w = 4186 \ J/kg \cdot °C$$

$$Q_{metal} = -Q_{water}$$

$$m_m c_m (T_{eq} - T_i) = -m_w c_w (T_{eq} - T_i)$$

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$$c_m = 453 \ J/kg \cdot °C$$

First Law of Thermodynamics:

- Relates energy, heat, and work done on a gas

$$\Delta U = Q + W$$

internal energy = heat + work done ON gas

- Two cases:

1. Isolated system initial and final energies are equal (not very interesting).

2. Cyclic process → process that begins and ends in same state (temp., volume, pressure)

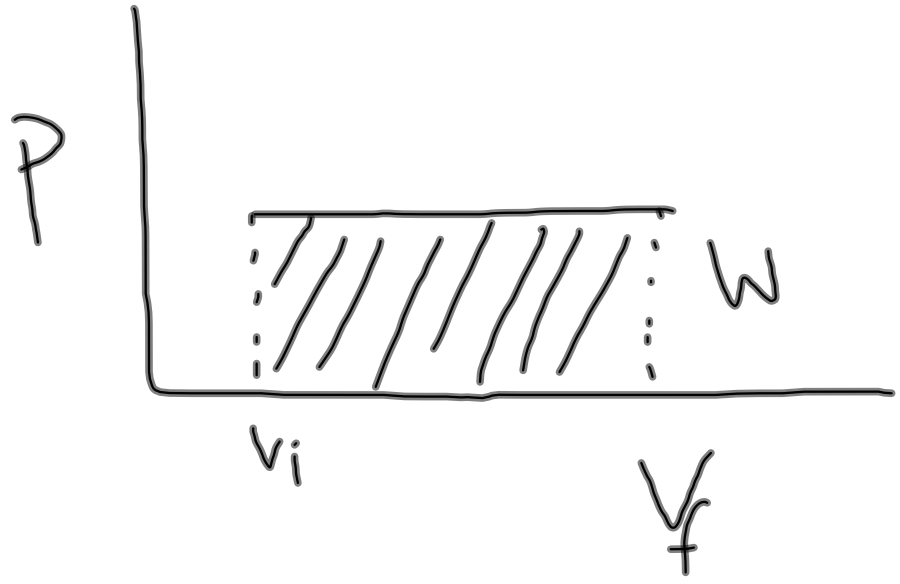
$$\Delta U = \emptyset$$

$$Q = -W$$

- Represent cyclic processes on PV diagrams, and they appear as closed curves.

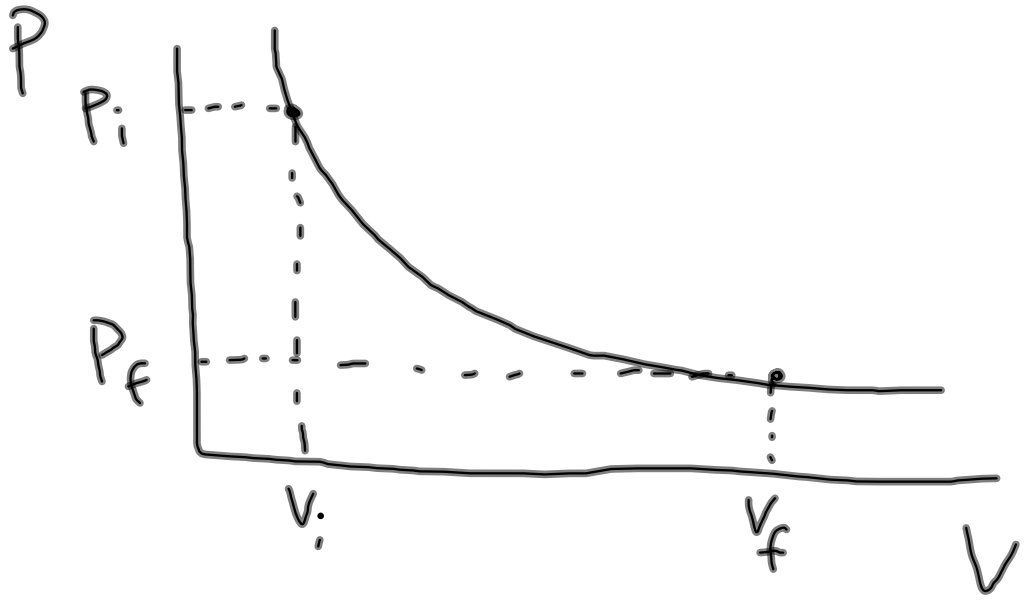
- Net work is equal to area

Process:	Work on Gas:	Heat:
Adiabatic	$W = \Delta U$	$Q = \emptyset$
Isobaric	$W = -P(V_f - V_i)$	$Q = nc_p\Delta T$
Isochoric	$W = \emptyset$	$Q = nc_v\Delta T$
Isothermal	$W = -Q$	$Q = -W$



Situation:	System:	Q	W	ΔU
Rapidly pumping up a bicycle tire	Air in the pump	Ø	+	+
Pan of room-temperature water sitting on a hot stove	Water in the pan	+	Ø	+
Air quickly leaking out of a balloon	Air originally in the balloon	Ø	−	−

Isothermal Expansion:



$$W = nRT \ln\left(\frac{V_i}{V_f}\right)$$

*temp. in Kelvins

A 1.0 mol sample of an ideal gas is kept at 0 degrees C during an expansion from 3 L to 10 L.
a) How much work is done on the gas during the expansion?
b) How much energy transfer by heat occurs between the gas and its surroundings in this process?
c) If the gas is returned to the original volume by means of an isobaric process, how much work is done on the gas?

a) $W = nRT \ln\left(\frac{V_i}{V_f}\right)$

$= -2733\ J$

b) $\Delta U = Q + W$

$\cancel{0} = Q + W$

$Q = +2733\ J$

c) $W = -P(V_f - V_i)$

$= -\frac{nRT_i}{V_i}(V_f - V_i)$

$= 1.6E3\ J$